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The Search for Reality

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Fellow microbiologists, friends of microbiology and of microbiologists: Search entails little ambiguity; reality we define as "reasonably reliable." For natural scientists, reality is an experimentally derived body of knowledge with explanatory and predictive value. The search for biological reality is a process familiar to most of you and to the rest through association.

The presently available body of biological knowledge, much of it accumulated by microbiologists, was undreamed of forty years ago. We are on the threshold of an understanding permitting a hitherto impossible rapid and extensive manipulation of natural and cultured living forms. Yet the challenging opportunity is appreciated by only a few. Many, ignoring or opposing scientific routes to reality, believing in other pathways, turn to mysticism, emotion, drugs, or violence.

Many current problems, chiefly socio-economic and political, are peripheral to science, yet they are important and so gravely affect microbiology that they need our attention. Scientists should assist in considering these problems and, without claiming aptitudes outside their speciality, contribute to the general fund of viewpoints from which policies and actions arise.

History can lend perspective to current problems. Biological history, evolution, records a more or less continuous process in which increasingly complex states of organization appeared from preexisting simpler states. We envision a grand panorama of progress through successive levels of organization leading ultimately to woman (regarded by most men as more desirable, and we trust vice versa).

Primitively "simple," elementary physical particles gave rise to protons and electrons. These spontaneously combined into atoms, more complex than the particles composing them, and with properties a result of but not completely predictable from the precursors. Atoms combined into molecules, and as temperatures dropped molecular complexity increased.

These molecules were almost infinite in variety, an innumerable population with myriads of characteristics. A new tendency appeared, a process of selection for molecular organizations such as nucleic acids, with capacities for metabolism and heredity. Whether heredity or metab-

olism evolved first is hidden in antiquity, but genetic replication in viruses without an accompanying viral genesis of ATP suggests a priority for heredity.

A linear chain of nucleic acids has become the mechanism for control of metabolism and the synthesis of new cells.

A linear arrangement of nucleic acids could have arisen through replication of a single molecule into a linear chain, with subsequent mutation, or through linear junction of independently evolved nucleic acids, each unique, into a mutualistic association. The latter seems the more rapid method to accumulate diverse characteristics within a single genome. Cooperation may have possessed value even at this early stage of evolution. One can even envision sexuality as arising through a primitive symbiotic complementation of independently evolved units.

At the step from linear nucleic acids to a primitive, procaryotic cell lies one of the biggest gaps in our conceptual scheme for evolution. In some fashion, the cell membrane originated, regulating the entrance and exit of materials, shielding the nucleic acid in its metabolic work of cell formation.

The step from the primitive cell to the eucaryotic cell of higher organisms is also obscure. Possible involvement of symbiosis in this step is seldom mentioned, yet the omnipresent self-duplicating mitochondria, chloroplasts, kinetosomes, and centrioles are consistent with development of the eucaryotic cell as a means for sequestering and perpetuating a primitive mutualistic association. Again, complementation through symbiosis brings diverse attributes together more rapidly than could replication from a single genome.

Once the complex cell evolved, a rational and consistent scheme of evolution can be postulated, in which higher categories of organization arise through aggregation of simpler units and their differential adaptation into the next higher evolutionary stage. Single cells developed into colonies from which multicellular organisms were derived. Multicellular organisms associated in linear fashion to become the segmented annelid, arthropod, or vertebrate, or in radial fashion to become the echinoderm.

The currently highest category of organization

is the society, expressed most prominently in insects and vertebrates. The human society is the largest and most complex biological organization on Earth. It holds more portent for Earth than do any of our companion species on this planet.

We assume that a population of planets (hopefully occupied by humanoids) is the next evolutionary category of organization; it may be nearer than we realize.

This review of the evolutionary track suggests a grand purposeful synthesis of the highly improbable creature, man. Indeed, it has been a grand process if we look only at the end result. When the mechanism is examined, no purposefulness is apparent. Overproduction, random variation, competition, and selection and elimination are empirical, not rational processes. Chance plays a part, and it is not possible to predict future events in more than very general terms.

In this evolutionary sequence, appearance of larger animals was inescapably accompanied by a reduction in the number of individuals composing the population. Societies are even fewer. Whereas 100 billion bacteria live in one gram of intestinal contents, the total number of humans is less than 4 billion, and the number of different human societies is in the hundreds.

Societal structures are selected out of competing units, but only a few competitors are needed for evolutionary change. Societies are seldom eliminated; each competitor adopts and adapts strengths (and weaknesses) of another; competing societies become increasingly alike, yet within each are innumerable diverse trends. This capacity for evolutionary change within a small population of societies is one of the most distinctive features of the societal stage of human evolution.

Just as the successful variant in body form or other characteristic of lower categories of evolution cannot be predicted, so also with societal form.

Rational and nonrational participation by many individuals determines societal change, but there is no highly evolved satisfactory mechanism to integrate individual beliefs and actions into a societal rationality. There is no means to divine which individual decision or view will or will not become a characteristic of any particular society. Mankind has achieved great control over many other aspects of his environment but he cannot control nor completely foresee the societal consequences of individual human actions. He cannot completely understand himself.

Since we cannot know for sure (low degree of reality) which ideas and views, if adopted, will ultimately prove valuable, why try? There is no alternative. The evolutionary process has selected

in living material a quality difficult to describe. It might be called push; perhaps living force is better. There is in living material a complex of characteristics in which strength to continue living is prominent. Humans are no exception. We try because we are alive, and with no assurance of success.

As your Secretary, Don Shay, mentioned when our representatives tried to influence decisions at the Xth International Congress of Microbiology in Mexico City last summer, "We may not accomplish anything, but nobody can say we didn't try." We strive because past events have selected for this characteristic. It lies at the basis of our combative traits; at many evolutionary stages survival as an individual was important. But the evolution of the human society selects also for cooperation. As individuals, our evolutionary heritage is to fluctuate between strife and collaboration.

Even though we cannot know the future course of societal evolution, we make value judgments affecting it. Each society has a cultural heritage, passed on and modified from one generation to the next. Among the innumerable possible human actions, some are better suited for survival of man and his society than are others. These we seek.

This completes our *historical* summary of some of the scientific aspects of the search for reality regarding the human organism. But *current* societal evolution involves individual views, uninformed, error-prone, and prejudiced as they may be, not to mention emotional. As a contribution to this population of ideas on which action is based, the remainder of this talk expresses personal views, no more worthy of attention than those any of you might express, but I hope also no less. I readily accept that these views can be dismissed as incurably romantic and impractical. Confinement of this talk to scientific views and attitudes might bring general agreement and approval; we might part with a sense of contentment and mutual congratulation and respect; but little would have been contributed toward understanding the important societal problems currently of greater import to the continued development of microbiology than are many of the problems of the science itself.

The most evident current societal competition is that between the so-called capitalists or free-enterprise bloc in which the United States is recently most prominent, and the so-called communist or totalitarian oligarchy bloc in which the Union of Soviet Socialist Republics has been most influential. There are no real signs of an accommodation. The officers of your society

hoped at Mexico City last summer that a plan for exchange of memberships with the microbiological societies of the U.S.S.R. could be implemented, with no exchange of funds. On our initiative, at a very friendly conference with the delegates from the U.S.S.R., a seemingly mutually acceptable plan was worked out. Pursuing the plan, on 18 September 1970, we wrote a letter detailing the privileges of membership in the American Society for Microbiology and offering them to U.S.S.R. members in return for an equal number of ASM memberships in the U.S. S.R. microbiological societies. No reply has been received.

The joint meeting disclosed many similarities between the forms of microbiological organization in the two countries.

At Mexico City great difficulty was experienced at the biological warfare conference in including any specific reference to the renunciation of offensive biological warfare by President Nixon. Only a reference to "unilateral" renunciation remained in the draft to be submitted to vote by the General Assembly. The next day at a special luncheon given by the U.S.S.R. delegation for the U.S. delegates, we were asked whether we would be willing to move at the General Assembly for withdrawal of the word "unilateral" and were also asked to move deletion of a statement recommending arbitration of any problems arising out of the resolutions. We rejected these suggestions on the basis that we favored the items and that the U.S.S.R. delegation, if opposed, should move their deletion. This was not done. The U.S.S.R. delegation did not attend the General Assembly at which the national delegates voted, and thus did not vote for the resolution, but were present at the final endorsement by the Plenary Session. One infers that the actions of the U.S.S.R. delegates were not their individual choice. It should be mentioned that, at the biological warfare conference, it was repeatedly pointed out that the United States had never ratified the Geneva Conventions.

I cite these examples not in criticism, for the delegates from both countries were most cordial in their personal relationships, but to show as objectively as possible the difficulties inherent in the resolution of differences between competing societies. To me the objection to the clause recommending arbitration was particularly interesting. At the founding of the United Nations in San Francisco, both the U.S.S.R. and the U.S. rejected compulsory arbitration, reserving a veto right.

It comes as a shock to the majority of U.S. citizens that some of the peoples of the world, who so enthusiastically embraced the concept

of democracy less than 200 years ago, now, as in Cuba, Chile, and Egypt, express a preference for a different system.

Our reaction to this challenge has been chiefly a maintenance of military strength and an investment of capital throughout the western world. Both may be valuable but each has its weaknesses. Have they achieved safety? Our military effort is expensive. Continued and increasing diversion of effort from peaceful to military purposes is one of the chief threats to a strong societal development. Valuable domestic programs are weakened, including many affecting and affected by microbiology. They are needed in maintaining vitality and strength. As an historian friend remarked, the only safety of a society is in its continued development.

My impression from military history is that societal groups, if align they must, align with the world bloc they fear the least. Our extensive military strength and stockpile of atomic weapons can disturb other peoples of the world, even though from our standpoint our military efforts are to counter aggression. Foreign investments have aided business in the open areas of world trade, but many people in these countries are unenthusiastic about U.S. economic domination.

Our military efforts have been largely defensive and have at best contained competitors in some areas, but competition breaks out in others. Could our defensive policy be inadequate, lacking a positive goal? An offensive military policy is repugnant to the majority of the people of the U.S., yet some sort of positive effort is needed. It must be examined realistically whether military and economic forces are adequate competitive weapons. Many question them. Is the current competition solely for military and economic control or is it also for the minds of men? A vital human spirit is seen by Toynbee as an important ingredient in societal success.

Whether we like it or not, communism receives the support of many dissatisfied peoples over the world. It is currently the only real alternative to our system. Has democracy in the free world modified and progressed rapidly enough in meeting human needs and aspirations? Does capitalism exist for all or only for some of its community? Can our military effort substitute for knowledge and tolerance of world peoples and cooperation with them? These questions can be asked in ascertaining whether the U.S., as the leader in the free world, is meeting the real competition. Are we living up to the true spirit of democracy in which each individual is respected as he contributes according to his ability and opportunity?

It is my personal conviction that we have had

an inconsistent attitude toward political and economic developments in "communist" countries. We have adopted the view that communism is bad, i.e., a poor system, not reliable, yet our preoccupied fear denotes a recognition of strength, as do our bolstered military and economic forces. Continued existence, expansion, and accomplishments are further indications of strength. Instead of denigrating the competing system, is it not wiser to examine our own system carefully and honestly and make constructive adjustments, demonstrating as a society an interest and a capability to meet the inherently difficult problems facing all humans? Can we see our real selves as we are, and improve on it?

We have made great strides toward assimilating peoples. The U.S. is a successful integration of diverse Europeans. It has an important component of Asian, African, and native American citizens not yet completely assimilated. Can they too be accorded the justice and equality of opportunity essential in a free and coherent society? Only time can tell; but it is my personal opinion, based on some observations over the world, that the United States stands a better chance than any other nation to demonstrate that external, easily recognized, racial differences are a trivial basis for societal evaluation of individuals as compared to traits such as reliability, industry, goodwill, and capacity for rational and objective evaluation of programs to serve the common welfare. Such a demonstration might be our most valuable competitive instrument.

What should be the role of the American Society for Microbiology in these matters? We should be a source of reliable microbiological knowledge, made widely available. We should represent and promote our science, taking into

account not only the science itself but also its service to humanity. We have a good record of service. We are grateful for the efforts and wise counsel of past and present members, officers, committees, employees, editors, editorial boards, authors, and their institutions. The program proposed for the new Board of Education and Training widens the scope of service the ASM can provide; we hope many members will find these extended opportunities attractive and rewarding.

What should be the policy of the American Society for Microbiology with regard to the peripheral but important socio-economic and political problems? It is unwise for it to serve as a political instrument in matters not specifically related to microbiology. It can provide opportunities for expression, if desired by its members, and in some cases polls of individual opinion may be appropriate; but expression of these as official attitudes or actions of the ASM itself should be avoided.

These problems are peripheral to our science, but tremendously important to it. Can we as individuals advance microbiology and, without compromising it, assist in formulating domestic and foreign programs to increase opportunity and understanding at home and abroad, and kindle and nourish hope for peaceful resolution of competitive crises? It is a tremendous challenge. We will not meet it completely, but we can search for and nurture those realities essential for continued human progress.

There are grounds for hope. Our ancestors met crises equally or more serious than those we face, yet since life's beginning 3 to 4 billion years ago no one of you ever lost an ancestor prior to maturity. Is there any valid reason to assume the trend will change? Is there any alternative to hope?